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Phonological surveillance of /p/ in comparison with /b/

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Abstract: This paper aims to focus, to bring the existing misperception of the letters 'p' and 'b' in panoramic view, to make the readers understand that there is nothing defective on the side of the speakers' in comprehending the sounds of the letters /p/ and /b/ when they listen to, alike other phonemic sounds. Further, it is to exercise the spectrographic picturization of the aforementioned letters for the scientific development, the theories involved in, and to bring out the linguistic phenomenon spread over the pronunciation of /p/ and /b/ phonemes.

Keywords: Phoneme, English, Sound, Arabic, Spectrum.

INTRODUCTION

Per Pamela Rogerson, "Difficulties can arise if English phonemes, those don‟t exist in the L1". For instance, if you converse with the native Arabic speakers, it is quite frequent to hear /b/ sound in place of /p/ as Arab students encounter trouble pronouncing the English letter /p/, as it doesn‟t exist in the Arabic language, so they spell it with the closest sounding letter "ba" (ب), which is repeatedly transcribed as /b/ of English. Ann Baker and Sharon Goldstein quoted it as a common problem that the speakers of Arabic may confuse /p/ and /b/, often replacing /p/ with /b/, but sometimes doing the reverse and replacing /b/ with /p/.

For example, you can hear:

"**P**oetry" sounds like "Boethri"

"**B**anda" for "Panda‟

"**b**arty‟ instead "party‟

"com**b**uter‟ for "computer"

This practice quite commonly prevailed in the Middle East region and this kind of pronunciation can be overheard in North Africa, such as Sudan, and Egypt even. The examples of this paper have been taken from the Jizan region of Saudi Arabia. I believe there are many teachers who found it trained the students practicing the sound, yet the result is the slightest. Accordingly, being an interested teacher of linguistics, I choose this to benefit the related knowledge to the contemporary environment, thus aimed to exemplify the whys and wherefores behind the difficulty of learning about the aforesaid allophones' differences in view of linguistics, and try to provide the possible solutions to teach the variation using phonemes. Furthermore, to add the subjects of McGurk effect and the spectrographic study to present with "discrepant" auditory images, for example, with the most audible syllable /ba/ simultaneously with the visual syllable /pa/, which is not the most frequent known response in the Arab region. The present study targets to clarify the perceptional contrasts by providing a possible explanation for this difference as the fact that indicated is significantly a higher prevalence of McGurk-type integration for phonemes /p/ and /b/ and the findings are discussed in terms of their inferences for the development of aural restoration programs for ESL learners of Arabic origin. Exactly to say, the main messages of this applied paper constitutes perception of the two phonemes, the ways to acquire it and phonetic analysis using a basic spectrum of speech science and the hypotheses associated with this concept.

Motive behind the mispronounce

Among the Arabic letters, the nearby letter which is similar to the English letter /p/ is, "ba" (ب). So, /p/ is usually realized as /b/ in written Arabic. The close Arabic equivalent of "ba" (ب) is similar to the English /p/ except that the Arabic letter ب (ba) is "voiced" as /b/ in English language, whereas /p/ is "voiceless".

Linguistic Context

To understand the root cause of this run through, it is necessary to look into the learner's native or L_1 language. There are 28 letters in the Arabic language and among those 28 letters, hardly any represents represent the linguistic formation of the English letter /p/. The precise articulation of vowels, consonants and their combinations is absolutely essential for the listener to comprehend the particular word that we speak. The oral parts like lips, teeth, soft palate, tongue, hard palate, are the organs above the vocal folds, and all together, constitutively expressed as vocal tract or articulators. Consonants are cognate pairs as they are articulated in the same place of manner and can be divided into two groupings called as voiced and voiceless. For example, in the present phonemes, linguistic terminology defines /p/ as a voiceless, bilabial and stop. To make it understandable, "Voiceless" is the sound where vocal cords do not vibrate while pronouncing it, bilabial where it is pronounced using tow lips, i.e. upper lip and lower lip, it is a stop too as it stops the air flow a little while. The letter /P/ may be aspirated [P^h] or un-aspirated [P=] or pre-glottalized or unreleased. If not, it is understandable, but with sloppiness. The counterpart of /p/ is /b/, which is voiced, bilabial and stop. It is a "Bilabial", because it can only be articulated by closing two lips, and it is a "stop" too, because articulating. this letter temporarily "stops" the flow of air in the mouth, but it is "Voiced" sound as vocal cords vibrate while uttering.

Production of the sound /b/:

Halt the air behind the lips and allow the air flow through the lips to expel as if it is escaping out from the mouth.

Eg. Words: **B**ell, la**b**el, lam**b** Phrases:**B**ulky **b**anana, **b**urn car**b**s

Sentence: It's the **b**est way to cur**b** the fa**b**rics.

Production of the sound /p/:

Halt the air behind the lips and allow the air flow through the lips to release the air with very little effort.

Eg. Words: **P**ulp, ca**p**tivate, jum**p**

Phrases: Unsur**p** the wra**pp**er, **p**rizing **p**om**p**

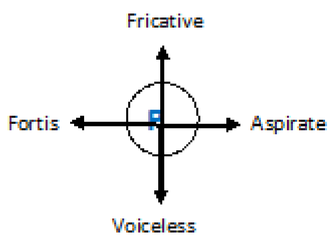
Sentence: The **p**ush **p**ull ex**p**ress is ready for **p**ublic transport.

Descriptions

During the use of "stops" in phonetics, the airflow ceases as the vocal tract blocks. The examples of stops are /p/ and /b/, /t/ and /d/, /k/ and /g/. Among these /p/, /t/, and /k/ are voiceless stops. The initial voiceless stops are aspirated as in *push, pan* with a palpable puff of air upon release. When these voiceless stops are spoken with initial placing as in *pack talk cake* near a candle flame, the flame will gleam more after the words. The unvoiced stop phonemes and the voiced stop phonemes is not just a matter of presence of articulatory voicing or not, rather it includes starting of voicing, the presence of aspiration, i.e. the burst of air flow followed by the closure and the duration of the closure too.

At this point, I would like to emphasize on four featured /p/ that need to be explained to the students in clear. The four features are:

- /P/ is a fortis- it is a consonant, particularly a voiceless consonant, strongly articulated, especially more so than another consonant articulated in the same place.
- /P/ is aspirate- pronounce (a sound) with an exhalation of breath.
- /P/ is voiceless-unvoiced sounds occur when there is no vocal cord vibration.
- /P/ is fricative- it is a consonant made by the friction of breath in a narrow opening, producing a turbulent air flow.



Picture-1: The four Properties of the phoneme /P/

It is possible and true to some extent that the learners will be able to distinguish /p/ from /b/, when they are exposed to these two sounds over and over. If a learner is exposed to the correct form of the language, they will adopt it. As the exposure to English language is limited, this procedure may take a little longer to the ESL learners.

Repetition of the sounds /p/ and /b/ alternatively, using the words of those syllables, give training to the articulation, consequently labial exercises are drilled to produce the same. So, the best way of giving practice is the use of *minimal pairs.*

__P__ie - __B__ye
__P__et - __B__et
__P__ride - __B__ride
Ni__pp__ing - Ni__bb__ing
Mo__pp__ing - Mo__bb__ing
Co__p__ – Co__b__
Ro__p__e – Ro__b__e
__B__ack - __P__ack

Aspiration

Attention on the production of aspiration in syllable initial /p/ by making learners aware of the gust of air that goes together with the release of the consonant. Use a piece of paper or the palm of the hand, held in front of the mouth so that the students can feel the puff of air produced for the voiceless stops. Otherwise, get learners to put a /h/ before the vowel and then add the voiceless stop before it.

For example:

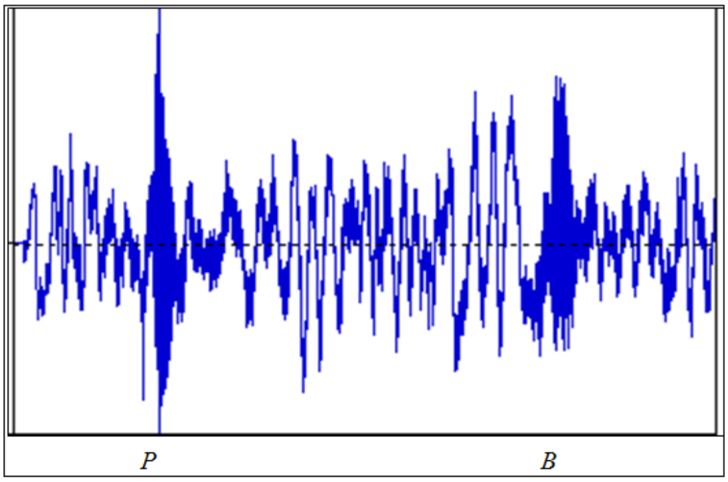
“ay”	“ow”
“hay”	“how”
“p(h)ay”	“c(h)ow”

A method that is used in CELTA/DELTA teacher training programs is, by holding up a piece of tissue paper and train the learners to produce /b/ few times and /p/ few times. After that, ask the learners what did they observe about the movement of the paper when they kept near the mouth. They could observe the articulation of /b/ does not produce any air explosion from the mouth and they answer that the paper moved every time when they articulated the letter /p/.

- The diaphragm is the key that regulates the body system. The observation of the movements of the diaphragm around the belly too gives consciousness of aspiration.
- To produce the phoneme /p/, air is briefly streaked from leaving the vocal tract by bringing the lips together. The sound is aspirated when the air is unrestricted. The release of air for the phoneme /p/ is greater than the aspiration for the phoneme /b/.

Speech Sound Spectra

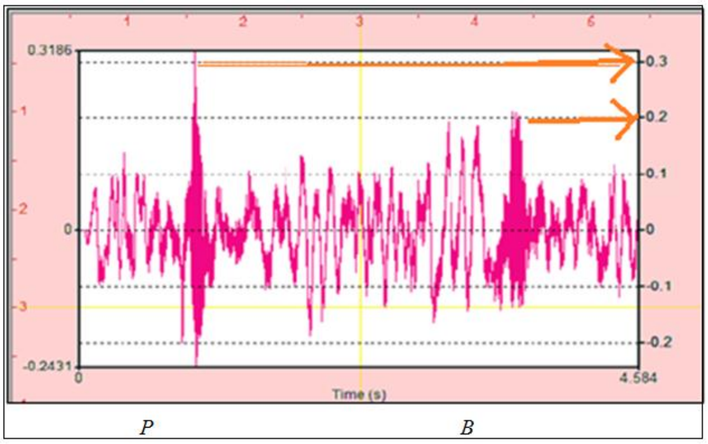
The spectrum is a kind of electronic voice phenomenon drawn by uploading a recorded audio file of a phoneme (consonant) through a phonetic software. The *spectrogram* is a three-dimensional plot and can be put on paper using praat software. The consonant sounds of the letters /p/ and /b/ are recorded and the spectrum was drawn using a phonetic software on a compatible system. The following (i) and (ii) figures are the subsequent electronic wave phenomenon of /p/ and /b/ phonemes on frequency and force on ‘x’ and ‘y’ axes. Change in amplitude corresponds to the change in frequency content.



Picture-2: Sound spectrum of /P/ and /b/

The above diagram shows a graphic representation of the spectrum (power / pressure / amplitude vs. frequency) for the simple sounds of the letters /p/ followed by /b/, pronounced by a Non-Arabic speaker. Power can be measured in decibles, whereas frequency in hertz (Hz-Vibrations per a second). Monthly Mystery Spectogam Webzone-Rob Hagiwara’s blog says *Voicing* is represented on a wide band spectrogram by vertical striations, especially in the lowest frequencies. Each vertical 'line' represents a single pulse of the vocal folds, a single puff of air moving through the glottis. We sometimes refer to a 'voicing bar', i.e. a row of striated energy in the very low frequencies, corresponding to the energy in the first and second harmonics. *Non-voicing* is basically silence, and doesn't show up as anything in a spectrogram.

Hence, voiced sounds are in a striated voicing bar and voiceless sounds without striated voicing bar. Though there are only two sounds recorded, the spectrum has many other frequencies with short peaks, are from the rumble traffic or other sounds of the surrounding environment. Some of the numerical models predict that air through the glottis and the vocal fold vibrations depend on the pressure differences across the glottis and folds, and thus causes waves in the tract [1-3]. The frequencies of the maximum heights are called peaks. These spectral peaks are also called as formants. The tuft of peaks indicated, at which length the sound has been uttered. This is the signal energy over the frequency of the phoneme /p/ and phoneme /b/. The unvoiced stop sound /p/ is a burst instant with a sort of Time vs. Power spectrum. It is hard to identify the burst with the increasing power rate.. The clear burst waveform is observed in the spectrum of unvoiced stops.



Picture-3: Representation of degree of variations in amplitudes of P and B

The above, second diagram shows a graphic representation of the spectrum (power vs. frequency in Hz) for the sound of the letters /p/ and /b/ with the variations in the height of the peaks, which in turn shows the difference of increase between the frequencies of /p/ over /b/ i.e. 0.3 and 0.2 simultaneously on top and almost the same on the other side . When the speed of sound is great, the resonances occur at higher frequencies. This enables to know that the surface membrane of the vocal folds also vibrates at the same frequency, nevertheless, the implications occur at the same frequencies [1-3]. The amplitude of the sound varies with time and the amplitude of unvoiced /p/ sound is much lower. The energy of the sound provides a picture that replicates these amplitude variations. The wavy horizontal line is the frequency-amplitude plane or spectral envelope, which describes a point in time. The spectral envelope wraps around the amplified spectrum by joining the peaks or heights. The vertical lines are shaped by the overtone of the vibration of the vocal folds. Spectral envelope is only minimally affected by fluctuations of the fine structure in either voiced or unvoiced sounds. The spectral envelope G(Ω) is represented by:

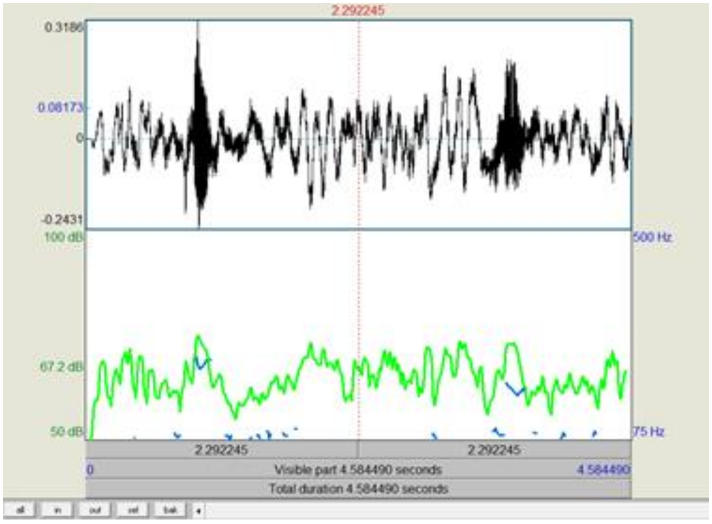
$$M\ G(\Omega)= \Sigma\ c(m) \cos (m\Omega)\ m=0$$

Whereas, c(m) = cepstrum for the minimum phase system
Cepstrum is defined as power spectrum of the logarithm of the power spectrum

As per many researchers, when the glottis opens for whispering, the resonance or formant peaks occur at higher frequencies [4-8]. The average opening of the glottis depends on what fraction of the time it is open (its "open quotient") and how far it opens [9-11], which in turn depends on the voice register and pitch. Nearly all information in speech is in the range of 200 Hz - 8 kHz, which is intelligible. The acoustic characteristics of voiceless consonants are approximated between 2 and 6 with an average of 4.8 kHz frequency range. The "Short time window analysis" is applied for the position for two frames.

There is a new group of moderators in voice research. The acoustics of the vocal tract are often modelled using a mathematical model of a filter [12]. The frequencies of the poles of the filter model plunge near to the formants. In consequence of that, voice researchers usually refer the frequencies of the poles as formants. Formant is each of numerous protuberant bands of frequency that define the phonetic quality of a vowel, which can be seen clearly in speech sound spectra. To some voice researchers, the formant refers to a peak in the spectral envelope. Spectral envelope is a property of the sound of the voice. To some other voice researchers, the format refers to a resonance of the vocal tract, whereas a new group of voice research moderators, the format refers to a mathematical filter model. The formant frequencies can be calculated by linear prediction analysis of the poles.

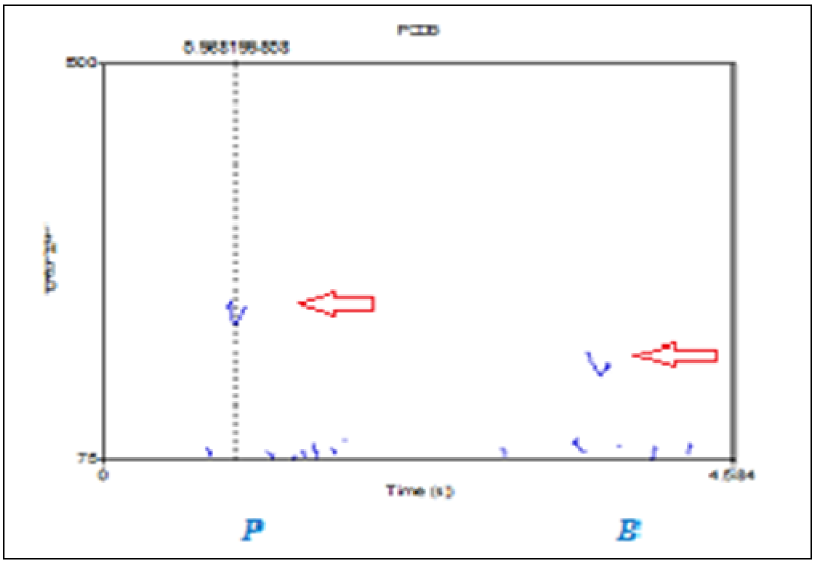
The phonetic analysis



Picture-4: Signal of Intensities of the sounds /P/ and /B/ below the spectrum

The study of a spectrum is a multifaceted development alike sound. The spectrogram is drawn taking time on the horizontal line and frequency in Hz on vertical line. The amplitude is shown by the degree of shading in black, in the above Spectrogram. This part of the spectrum shows two dark areas too. The darker the color indicates the darker the bands of frequency. The strips in black, in the spectral envelope are the vibrations of the vocal folds. The green line represents the level of intensity of the sound spoken. The blue line in the spectrogram designates pitch. The intensity of the pitch is measured in decibels. Not only the pitch variation between voiced and unvoiced, the frequencies of the formants are different as well.

Pitch parameter



Picture-5: Picture showing the difference in pitch levels of the sounds /P/ and /B/

The above is the pitch contour, that gives a clear picture of difference in pitch for the phonemes /p/ and /b/. The pitch parameter extractor consists of a voiced-unvoiced (V/UV) decision associating with the average value of the spectral envelope components in the fundamental frequency region, and Noll's cepstral peak picking. Climent Nadeu, Jordi Pascual and Javier Hernando quoted that the voiced-to-unvoiced and unvoiced-to-voiced error rates are 0.7-1.5% and 1.5-2.5%, respectively. These error rates are fairly lower than those observed using cepstral peak picking. Pitch analysis, autocorrelation function and zero crossing rate is usually the methods used to make voiced-unvoiced decisions [13]. In the proposed system, speaker dependent classification of voiced and unvoiced phonemes was made by using line spectrum frequencies. These are automatically constructed two classes of phonemes with respect to their articulation. According to Jacob Benesty, M. M. Sondhi, Yiteng Huang [14] the voiced sounds have periodicity, the spectrum possesses a line spectral structure consisting of a basic frequency and harmonics, therefore, noise can be decreased by leaving only this spectral part while suppressing the other parts. The accuracy of this method is determined by how accurately the pitches are distinguished voiced sounds can be detected from voiceless sounds.

The pitch detection method is the most orthodox autocorrelation function method. Pitch is the essential frequency of the vocal folds' vibrations. The voiced sounds namely vowel, semivowel and nasal sounds are pseudo periodic waves, hence, the basic pitch frequency is calculated from the autocorrelation function point that has the maximum level. The correlation value distinguishes voiced from voiceless sounds. Thus, there is no pitch for voiceless stops and fricatives such as /p/, /t/, /k/, /th/ & /ch/ and /f/, /s/.

The Fact

The first and foremost proof of speech comprehension is by listening and the observation of visual evidence of the lip movements, simultaneously and voluntarily. The listeners use the sound they heard and the visual prompts in the interim to understand and to continue the speech, also to cover the auditory information which is unheard. What is more interesting is that people use visual cues to process speech, even when the auditory signal is perfect [15], and a powerful multisensory illusion occurs with audiovisual speech, they added. The combining of aural and visual prompts during speech observation is termed audio-visual integration. The phenomenon is "The McGurk Effect" has been used to explore this audio-visual integration. Alsius *et al*., [16] exemplified as audiovisual integration impairment using reduced McGurk effect, for that instant Green *et al*., [17] provided a good example i.e. dubbing a male voice onto a female talker and vice versa. The aural speech is recognized alone though, it is heard as another consonant after dubbing with different visual speech. The illusion has been named as "McGurk effect" or "Fusion effect". Many researchers have defined the McGurk effect exclusively as the fusion effect because here integration results in the perception of a third consonant, obviously merging information from an audition and vision [18-20]. Later, interestingly, the McGurk effect is generated even when acoustic and visual speech inputs come from clearly different directions [21]. This illusion has been used by MacDonald and McGurk [22] themselves, and also by quite a lot of others [23, 24]. This issue has been elaborated previously in the extensive work by Massaro and colleagues [25-28]. It is essentially vital because the identification accuracy of unisensory components is reflected into audiovisual speech perception. However, already McGurk and MacDonald [15] themselves wrote that "Lip movements for [pa] are frequently misread as [ba]", because of perceptual illusion, where the visual input of the phoneme /p/ makes the Arabic listener miscomprehend to hear it as the known sound /b/ as the labial movement is quite similar to both the phonemes.

CONCLUSION

The aforementioned discussion furnishes the information about the analysis of voiced /b/ and unvoiced /p/ sounds. The voiced phoneme /b/ and unvoiced phoneme /p/ is an important research gizmo that shows that auditory and visual information is merged into an integrated percept, and the strength of an audiovisual integration has been proven through McGurk effect. The McGurk effect is a clear-cut variation in auditory speech is persuaded by visual perception, results in hearing a single precept, something other than what is said. This type of complex articulation involves "...separate and successive articulatory activities which together can be identified as a single segment" [29].

Fortis stops, /p, t, k/ are aspirated [p^h, t^h, k^h] when they occur at the beginning of a word, as in *tap*, *tomato* or at the beginning of a stressed syllable in the middle of a word, as in *potato*. They are un-aspirated [p, t, k] after /s/, as in *stopper, spin, scate*, and at the ends of syllables, as in sa*t, cap, luck*. This helps the learners to pronounce the phoneme /p/ correctly and also serves as a self-assessment tool by which they can measure their own pronunciation and accuracy. The order of sound acquisition by young children, Owens [30] concluded the following: Among the consonant sounds, children generally first acquire the nasals, followed by the stops, glides and liquids, fricatives and affricates. Consonants, however, are more complicated to produce. The ways of producing consonants, or Manner of articulation, made stops, nasals, fricatives, affricates, glides, and liquids [31]. It is true a statement that the earliest sounds the children produce are the simplest for them to articulate, using the structure of their present vocal tract. These sounds are the vowels, nasals, and stops [32]. Speech production structures vary among sounds in accordance with the different style of articulations. Therefore, it is compulsory to apply an appropriate method to each sound in order to extract the essential features for syllable or phoneme recognition in continuous speech.

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